Enclosure to

BVY 13-015

Entergy - Vermont Yankee

Overall Integrated Plan for Reliable SFP Instrumentation

Entergy – Vermont Yankee (VY)
Overall Integrated Plan for Reliable Spent Fuel Pool Instrumentation: EA-12-051

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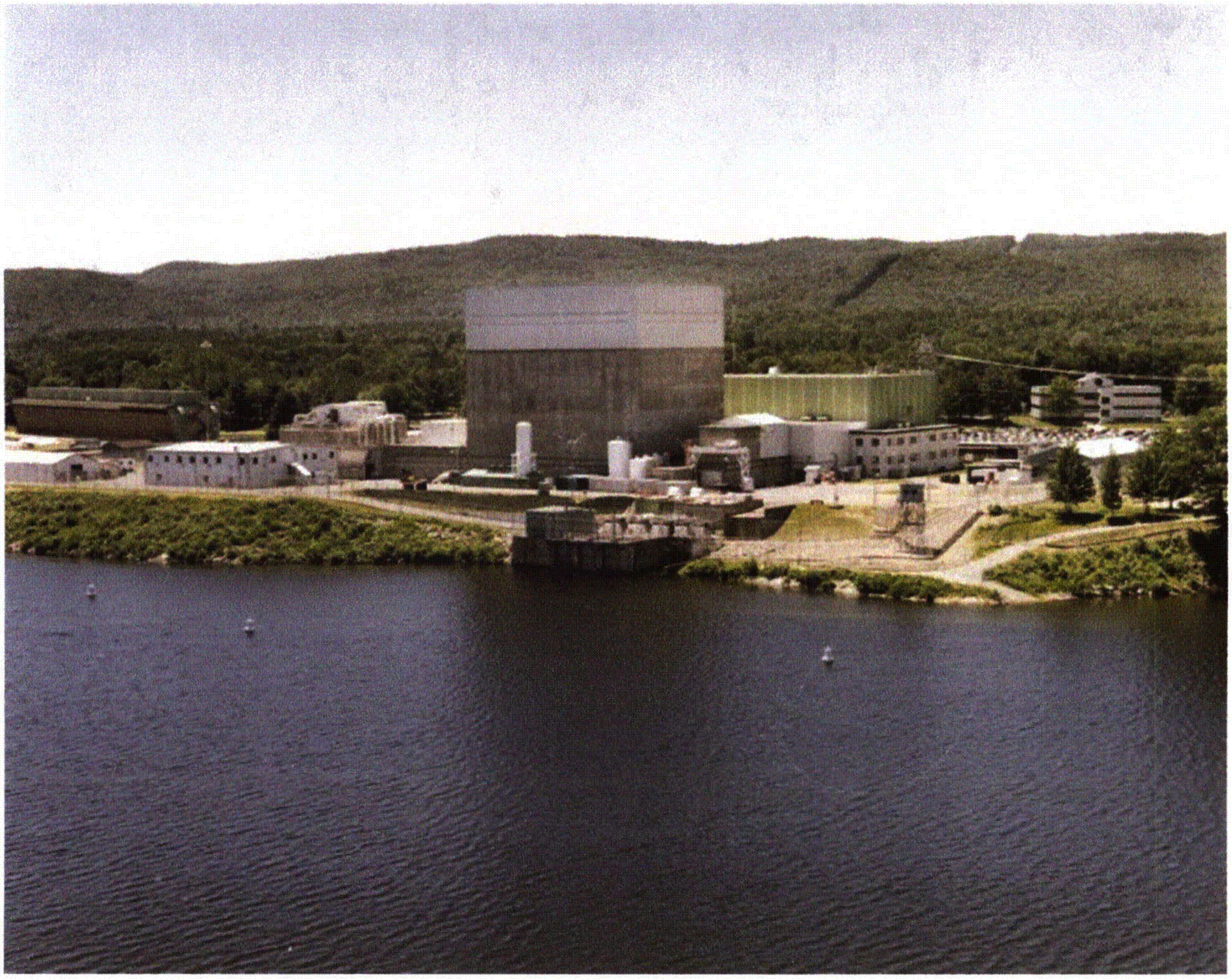

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For Reliable Spent Fuel Pool Instrumentation

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RECORD OF REVISION

Revision	Date	Description of Change
0	23 Jan 2013	Initial Issue

Vermont Yankee Overall Integrated Plan for Reliable Spent Fuel Pool Instrumentation

Introduction

The Nuclear Regulatory Commission (NRC) issued Order EA-12-051, *Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, (Reference 1) on March 12, 2012. The Order requires licenses to have a reliable indication of the water level in spent fuel storage pools. The indication must permit identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system, (2) level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred. The Order also requires submittal of an overall integrated plan that describes how the requirements of the Order will be achieved.

NEI 12-02, *Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,"* (Reference 2) provides an approach for complying with the Order. NRC Interim Staff Guidance JLD-ISG-2012-03 Revision 0, "*Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation*" (Reference 4) evaluated the methodologies and guidance in NEI 12-02 Revision 1 and considered them an acceptable method of complying with the Order subject to the clarifications and exceptions related to Qualification in Section 3.4 of NEI 12-02 Revision 1.

This Overall Integrated Plan describes the Vermont Yankee (VY) Unit 1 approach for complying with Order EA-12-051 using the methods described in NEI 12-02 Revision 1 and NRC JLD-ISG-2012-03 Revision 0. The current revision of the Overall Integrated Plan is based on a conceptual design. If the final design is different than described in this plan, then the integrated plan will be revised and resubmitted.

Consistent with the requirements of Order EA-12-051 and the guidance in NEI 12-02 Revision 1, six-month reports will describe progress made, any proposed changes in compliance methods, schedule updates, and if needed, requests for relief and the bases.

1. **Applicability**

This Overall Integrated Plan applies to Vermont Yankee Unit 1.

2. **Schedule**

The installation of reliable spent fuel pool level instrumentation is scheduled for completion prior to startup from the fall 2014 refueling outage. This is the end of the second refueling outage following submittal of this integrated plan.

3. **Identification of Spent Fuel Pool Water Levels**

Key spent fuel pool (SFP) water levels, including the three critical levels defined in NEI 12-02 Revision 1 will be identified in related station guidance. Both the primary and backup instrument level channels are permanent, mounted directly within the SFP, and will measure level over a single continuous span from above level 1 down to below the upper limit of level 3 (taking into account instrument uncertainty). Access to the SFP area is not required to operate the instrument channels or obtain level data. Displays and signal processors will be located in the Main Control Room (MCR) and will be readily accessible. Each channel displays indicated level to reasonably high accuracy when accounting for worse case environmental conditions and instrument uncertainties. A channel accuracy or instrument loop uncertainty of ± 3 inches is applied which is conservative and bounding thereby precluding the need for formal accuracy analyses. As such, SFP level instrument span or range will be 3 inches or more *above* Level 1 and 3 inches or more *below* the Level 3 upper limit. The three critical levels are as follows:

- **LEVEL 1**: Level 1 is the level adequate to support operation of the normal fuel pool cooling system. It is the higher of the following two points:

  (1) The level at which reliable suction loss occurs due to uncovering the coolant inlet pipe or any weirs or vacuum breakers associated with suction loss. For VY, the level, (1), is established based on the level at which the SFP cooling pumps automatically trip which is at elevation 343 feet 1 inch (Reference 6). This elevation is above the point where the pumps lose suction (Reference 7).

  (2) The level at which the normal fuel pool cooling pumps lose required NPSH assuming saturated conditions in the pool. An evaluation will be completed to demonstrate that this elevation is below the elevation that defines Level 1.

  The higher of the above points is (1). Therefore, <u>LEVEL 1 is elevation 343 feet 1 inch.</u>

- **LEVEL 2**: Level 2 is the level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck. Level 2 may be based on either of the following:

  (1) 10 feet ± 1 foot above the highest point of any fuel rack seated in the spent fuel pool. The elevation associated with this level is 331 feet 3 inches ± 1 foot (i.e. Level 3 + 10 feet).

  (2) A designated level that provides adequate radiation shielding to maintain personnel dose within acceptable limits while performing local operations in the vicinity of the pool. This level is based on plant-specific or appropriate generic shielding calculations. The elevation associated with this level is not calculated since item (1) is used to establish Level 2 as permitted by NEI 12-02 Revision 1.

  Therefore, <u>LEVEL 2 is elevation 331 feet 3 inches</u> ± 1 foot (i.e. 10 feet above Level 3).

  The equipment and instructions needed to reestablish SFP inventory will be provided as required by NEI 12-06 (Reference 3). This guidance will require action to reestablish SFP inventory upon or before reaching Level 3.

- **LEVEL 3**: Level 3 is the level where fuel remains covered. It is defined as the highest point of any fuel rack seated in the spent fuel pool (within ±1 foot).

  The highest point of any fuel rack seated in the spent fuel pool is elevation 321 feet 3 inches (Reference 8). Therefore, <u>Level 3 is elevation 321 feet 3 inches ± 1 foot</u>.

  The SFP level instrument span will extend down to at least 3 inches below the upper limit of the range of LEVEL 3 to account for accuracy or instrument loop uncertainty. Therefore, the SFP level probe will extend down to at least 322 feet 0 inches.

4. Instruments

The design of the instruments will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1. Specifically, the channels will be designed as discussed below.

Primary (fixed) Instrument Channel (Channel A)

The primary instrument channel is a permanent, fixed channel and located at the approximate locations shown on Attachment 1. The primary instrument channel will provide level indication through the use of Guided Wave Radar (GWR) technology using the principle of Time Domain Reflectometry (TDR). The instrument provides a single continuous span from above Level 1 to within 1 foot of the top of the spent fuel racks.

Backup Instrument Channel (Channel B)

The backup instrument channel is identical to the primary channel and is a permanent, fixed channel. Components are located in the approximate locations shown on Attachment 1. The backup instrument channel will provide level indication through the use of Guided Wave Radar (GWR) technology using the principle of Time Domain Reflectometry (TDR). The instrument provides a single continuous span from above Level 1 to within 1 foot of the top of the spent fuel racks.

5. Reliability

Reliability of the primary and backup instrument channels will be assured by conformance with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1, as discussed in Section 9, Qualification.

6. Instrument Channel Design Criteria

Instrument channel design will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1.

Instrument channels will consist of a corrosion and radiation resistant metal probe submerged in the pool and connected to a corresponding display/processor by coaxial cable. The probe will span the length of the measured range of pool levels. It will be seismically mounted. The probe will be designed to operate in borated and non-borated water over the entire expected range of pool conditions from normal temperatures to boiling temperatures. Cables and connections are designed for expected radiation levels and environments of greater than 212 degrees F and 100 % humidity. Probes, cables, connectors, and mounting hardware in the area of the SFP will be designed to function after the effects of seismically induced sloshing.

In the SFP area, cables shall be routed in seismically mounted rigid metal conduit. Outside the pool area, cables shall be routed in seismically mounted rigid metal conduit, trays, or raceways. Display/Processors shall be mounted in promptly accessible areas outside of the SFP area as defined in Section 14.

Channels shall be physically separated by routing instrument cables in separate conduits, trays, or raceways, locating sensors on opposite sides of the pool near the corners, etc. Physical channel separation will be maintained down through and including each channel display/processor where convergence may be allowed so the display/processors can be located in close proximity or side by side.

Movement of the probe during a seismic event will not damage the pool liner and will not result in contact with spent fuel. Indication will remain reliable after a seismic event.

Minor debris buildup on the probe will not impact performance.

7. **Arrangement**

Level instruments will be installed in the approximate locations shown on Attachment 1. Separation of the channels/probes reduces the potential for falling debris or missiles affecting both channels of instrumentation. This placement coupled with separate routing paths for cables and the use of rigid conduit provides reasonable protection against falling debris and structural damage.

Instrument power is derived from the display/processors. The location of the display/processors is in the Main Control Room as shown on Attachments 1 and 2. This location is expected to be a mild environment after a Beyond Design Basis External (BDBE) event and is easily accessed; therefore, personnel can promptly obtain readings from the display. This location provides adequate protection against the effects of temperature, flood, humidity, radiation, seismic events, and missile hazards.

The display/processors are normally powered using 120VAC that is provided from separate 480V buses at a minimum. On loss of normal AC power, each processor automatically continues to operate on its own dedicated backup battery supply. The backup batteries and associated UPS are located at the processor, seismically mounted, and qualified for the expected environment. The processor will also have connections designed to allow powering the processor from an external, portable DC source.

8. **Mounting**

Bothe the primary and backup system will be installed as seismic Category I to meet the NRC JLD-ISG-2012-03 and NEI 12-02 guidance requirements.

Other hardware stored in the SFP will be evaluated to ensure that it does not adversely interact with the SFP instrument probes during a seismic event.

9. **Qualification**

Design criteria will ensure instrument channel reliability during normal, event, and post-event conditions for no fewer than seven days or until off-site resources can be deployed. Analyses, operating experience, and/or manufacturer testing of channel components will be used to validate design criteria and will consider the following:

- Post event conditions in the area of instrument channel components
- Effects of shock and vibration on all instrument channel components
- Seismic effects on instrument channel components during and following a potential seismic event.

Components in the area of the SFP will be designed for the temperature, humidity, and radiation levels expected during normal, event, and post-event conditions for no fewer than seven days post-event or until off-site resources can be deployed by the mitigating strategies resulting from Order 12-049 Revision 0, *Order Modifying Licenses With Regard to Requirements for Mitigation for Beyond-Design-Basis External Events.* Examples of post event conditions that will be considered are:

- Radiological conditions for a normal refueling quantity of freshly discharged (100 hours) fuel with SFP water level within 1 foot of the top of the SFP racks (Level 3),
- Temperature of 212 degrees F and 100% relative humidity environment,
- Boiling water and steam environment
- The mitigating strategies developed in response to NEI 12-06, Diverse and Flexible Coping Strategies (FLEX).

Equipment located in the SFP will be qualified to withstand a total accumulated dose of expected lifetime at normal conditions plus accident dose received at post event conditions with SFP water level within 1 foot of the top of the fuel rack seated in the spent fuel pool (Level 3).

The metal probe and cable in the spent fuel pool area are robust components that are not adversely affected by expected radiation, temperature, or humidity. The areas selected for display/processor installation are considered mild environments, such that personnel access is not prohibited by radiation, temperature or humidity, and are readily accessible by operators during or after a BDBE event.

Components of the instrument channels will be qualified for shock and vibration using one or more of the following methods:

- Components will be supplied by manufacturers that implement commercial quality programs (such as ISO9001, Quality Management Systems – Requirements) with shock and vibration requirements included in the purchase specification at levels commensurate with portable hand-held devices or transportation applications;
- Components have a history of operational reliability in environments with significant shock and vibration loading, such as portable hand-held device or transportation applications; or
- Components are inherently resistant to shock and vibration loadings, such as cables.

For seismic effects on instrument channel components used after a potential seismic event for only installed components (with the exception of replaceable batteries and chargers), the following measures will be used to verify that the design and installation is adequate:

- Components will be rated by the manufacturer (or otherwise tested) for seismic effects at levels commensurate with those of postulated design basis event conditions in the area of instrument channel component use using one or more of the following methods:
    - Demonstration of seismic motion will be consistent with that of existing design basis loads at the installed location;
    - Substantial history of operational reliability in environments with significant vibration, such as for portable hand-held devices or transportation applications. Such a vibration design envelope will be inclusive of the

effects of seismic motion imparted to the components proposed at the location of the proposed installation;

  - demonstration of seismic reliability using methods that predict equipment performance (e.g., analysis, testing, combination thereof, or use of experience data) where demonstration should be based on the guidance in Sections 7, 8, 9, and 10 of Reference 5 or a substantially similar industrial standard;
  - Demonstration that proposed devices are substantially similar in design to models that have been previously tested for seismic effects in excess of the plant design basis at the location where the instrument is to be installed (g-levels and frequency ranges); or
  - Seismic qualification using seismic motion consistent with that of existing design basis loading at the installation location.

- Augmented quality requirements will be applied to all components in the instrumentation channels for:
  - design control
  - procurement document control
  - instructions, procedures, and drawings
  - control of purchased material, equipment, and services
  - inspection, testing, and test control
  - inspections, test, and operating status
  - nonconforming items
  - corrective actions
  - records
  - audits

10. Independence

The primary instrument channel will be independent of the backup instrument channel. Independence is obtained by physical separation of components between channels and the use of normal power supplied from separate 480V buses. Independence of power sources is described in Section 11. The two (2) permanently mounted instruments in the pool are physically separated as described in Section 6 and 7.

11. Power Supplies

The power supplies for the instrument channels are shown on Attachment 2 and arranged as follows:

- Each instrument channel is normally powered from 120VAC 60 Hz plant power to support continuous monitoring of SFP level. The primary channel receives power from a different 480V bus than the backup channel. Therefore, loss of any one 480V bus does not result in loss of normal 120VAC power for both instrument channels.

- On loss of normal 120VAC power, each channel's UPS automatically transfers to a dedicated backup battery. If normal power is restored, the channel will automatically transfer back to the normal AC power.
- The backup batteries are maintained in a charged state by commercial-grade uninterruptible power supplies. The batteries are sized to be capable of supporting intermittent monitoring for a minimum of 3 days of operation. This provides adequate time to allow the batteries to be replaced or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049 Revision 0.
- An external connection permits powering the system from any portable DC source.
- Instrument accuracy and performance are not affected by restoration of power or restarting the processor.

12. Accuracy

Accuracy will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1. Accuracy and indication features are as follows:

- Accuracy: The absolute system accuracy is better than ± 3 inches. This accuracy is applicable for normal conditions and the temperature, humidity, chemistry, and radiation levels expected for BDBE event conditions.
- Trending: The display trends and retains data when on either normal or backup power.
- Restoration after Loss of Power: The system automatically swaps to available power (backup battery power or external DC source) when normal power is lost. Neither the source of power nor system restoration impact accuracy. Previously collected data is retained.
- Diagnostics: The system performs and displays the results of real-time information related to the integrity of the cable, probe, and instrument channel.

The above features ensure that trained personnel can easily determine when SFP level falls below each regulatory level (Levels 1, 2 and 3) without conflicting or ambiguous indication.

13. Testing

Testing and calibration will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1 and vendor recommendations.

The display/processor performs automatic in-situ calibration and automatically monitors for cable, connector, and probe faults using time domain reflectometry (TDR) technology. Channel degradation due to age or corrosion is not expected but can be identified by monitoring trends.

Station procedures and preventive maintenance tasks will be developed to perform required surveillance testing, calibration, backup battery maintenance, functional checks, and visual inspections of the probes.

14. Display

The primary and backup instrument displays will be located in the Main Control Room as shown on Attachments 1 and 2.

The display will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1.

For both normal and expected beyond design basis conditions, the displays are in mild environments that are:

- Promptly accessible to plant staff and decision makers properly trained in the use of the equipment. Station operators can obtain SFP level data trends and report those to decision makers within 30 minutes of request.
- Outside the area surrounding the SFP floor and protected from the environmental and radiological sources resulting from an event impacting the SFP.
- Inside a seismic structure that provides protection from adverse weather or flooding.
- Outside of any high radiation area or locked high radiation area during normal or expected beyond design basis conditions.

15. Instrument Channel Program Criteria

The program criteria will be consistent with the guidelines of NRC JLD-ISG-2012-03 Revision 0 and NEI 12-02 Revision 1 as described below.

Training

The Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service.

Procedures

Procedures for maintenance and testing will be developed using regulatory guidelines and vendor instructions.

BDBE event operation guidance will also address the following:

- A strategy to ensure SFP water addition is initiated at an appropriate time consistent with implementation of NEI 12-06 Revision 1.
- Restoration of non-functioning SFP level channels after an event. Restoration timing will be consistent with the emergency condition. After an event, commercially available components that may not meet all qualifications may be used to replace components to restore functionality.

16. Need for Relief and Basis

There are no exceptions to the requirements of EA-12-051 or NEI 12-02 Revision 1 as endorsed by JLD-ISG-2012-03 Revision 0; therefore, there is no request for relief.

Consistent with the requirements of Order EA-12-051 and the guidance in NEI 12-02 Revision 1, six-month update reports will be submitted to the NRC to provide progress and schedule updates, identify any changes in compliance methods, as well as any requests for relief and their bases.

17. References

1. EA-12-051, Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, March 12, 2012
2. NEI 12-02 Revision 1, Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,"
3. NEI 12-06 Revision 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide
4. NRC Interim Staff Guidance JLD-ISG-2012-03 Revision 0, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation
5. IEEE Standard 344-2004, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
6. Procedure ON 3157 Revision 10, ER 981818-02
7. Drawing G-191173 Sh. 1, Revision 40, Flow Diagram Fuel Pool Cooling & Cleanup System
8. Drawing 5920-12795 Revision 0 – POOL LAYOUT SPENT FUEL STORAGE RACKS
9. EA-12-049 Revision 0, Order Modifying Licenses With Regard to Requirements for Mitigation for Beyond-Design-Basis External Events

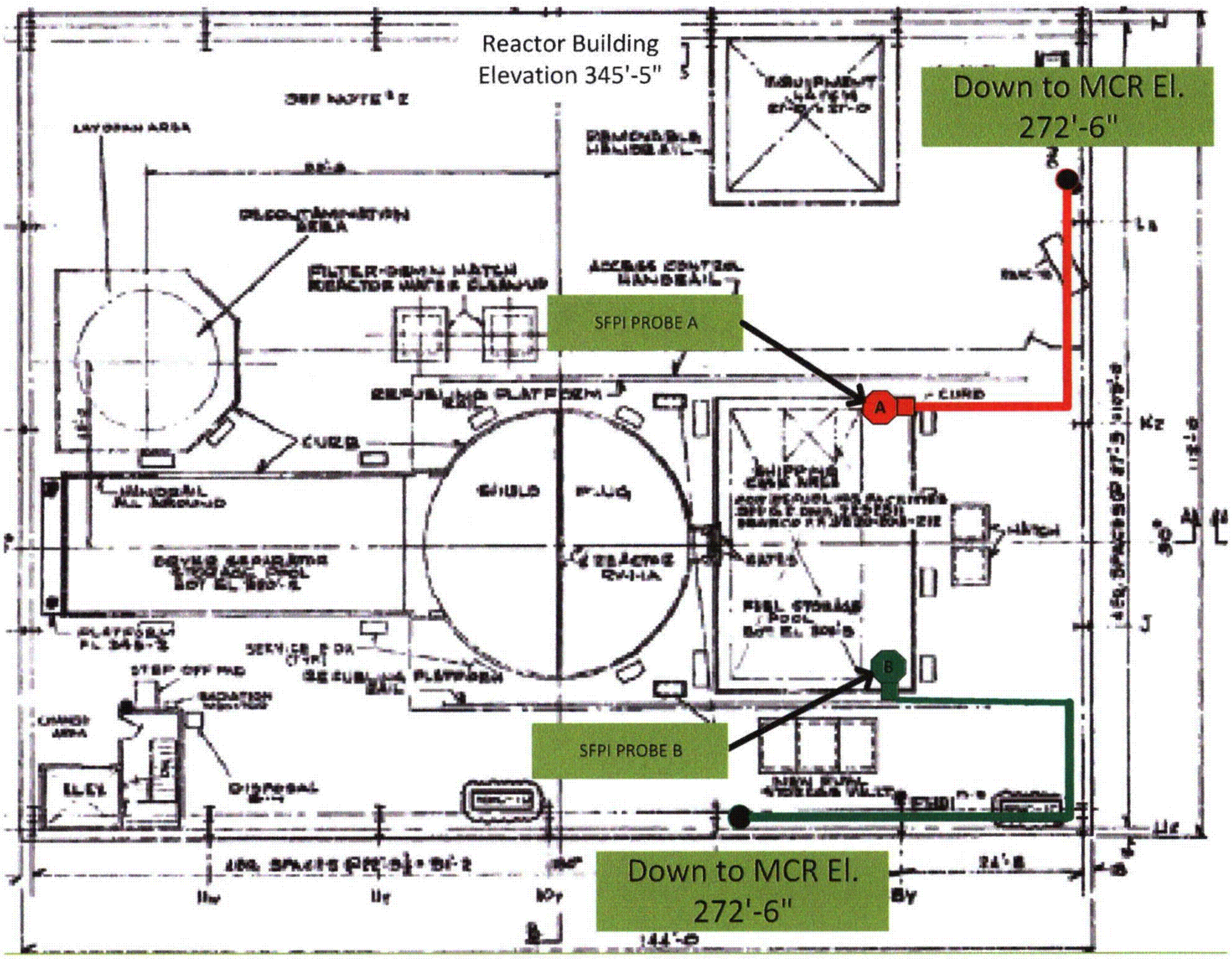
18. Sketches

Attachment 1: SFPI Simplified Spent Fuel Pool Instrument Locations and Approximate Cable Routing

Attachment 2: SFPI Simplified Connection and Power Supply Diagram

Attachment 1

SFPI Simplified Spent Fuel Pool Instrument Locations and Approximate Cable Routing



Attachment 2

SFPI Simplified Connection and Power Supply Diagram